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COMPARISON EFFECTS OF SILVER NANOPARTICLES, GLYCEROL AND ALUMINIUM SULPHATE AS VASE HOLDING SOLUTIONS ON VASE LIFE ATTRIBUTES OF CUT ROSE (*ROSA* X*HYBRIDA*) VAR. TAJ MAHAL

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ABSTRACT

Rose is one of the most sought after cut flowers globally. The naturally short vase life of cut roses is an impediment. Concerted efforts have always been taken up to tackle this issue. In this study, effects of vase holding solutions on water relations of rose var. Taj Mahal were evaluated. The present study was carried out at the Postharvest Technology Laboratory, College of Horticulture, Bengaluru. Flowers were held in five preservative solutions containing sucrose + citric acid and also in combination with 50 and 20 ppm nanosilver, glycerol (6%) and aluminium sulphate (300 ppm). During vase period, water uptake, relative fresh weight, transpiration loss and water balance were measured. Both the nano silver treatments extended the vase life compared to the other treatments. Among these treatments, the concentration of 20 ppm SNP in combination with sucrose 1.5% + citric acid 300 ppm showed the highest water uptake and highest relative fresh weight (%) till the final day of study. This study emphasizes the fact that, in the present context, silver nanoparticles are one of the best available technologies in delaying the postharvest degradation in rose cut flowers.

***KEYWORDS:** Rose Flower, Silver Nanoparticles, Vase Life, Water Uptake, & Relative Fresh Weight*

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Original Article

INTRODUCTION

Rose (*Rosa* spp.) is one of the highest in demand cut flowers in the world and has a limited commercial value due to early dehydration (van Doorn, 1997). Numerous investigations have demonstrated the helpful effects of various chemical additives on the postharvest water relations and extending the vase life of cut rose flowers (Ichimura and Shimizu, 2007). The difference between water uptake and water loss (water balance) determines the quality and longevity of cut flowers (Da Silva, 2003).

Recently, most of the studies concentrated on maintaining the longevity of cut flowers by adding some chemical compounds to the vase solution. 8-hydroxyquinoline is broadly used, although it is very expensive and most harmful preservative for human causing irritation to skin, eyes and respiratory tract (Shanan*et al.*, 2010). Application of silver thio sulphate (STS) is restricted because it contains silver as heavy metal that is toxic for environment (Shimamura*et al.*, 1997) and it has been banned in several countries (Marandi *et al.*, 2011). Nowadays silver nitrate is not used in commercial vase solutions because of the danger for human health and environmental risk (Damunupola and Joyce, 2006). Therefore, to avoid use of these harmful chemicals, developing a novel

substance as an alternative to these chemicals are utmost important for floriculture industry.

The use of silver nanoparticles (SNP) in particular has become common recently because of their antimicrobial effects in pharmaceutics, cosmetic and textile applications. Silver nano-particles have high surface area. Nano-silver (NS) is a novel antimicrobial compound that can kill 650 species of bacteria in water (Morones*et al*., 2005). NS is thought to release mono valent silver ions (Ag^+) which replace the hydrogen cation (H^+) of sulfhydryl or thiol groups (-SH) on surface proteins in bacterial cell membranes, thereby decreasing membrane permeability and eventually causing cell death (Feng *et al*., 2000). NS is currently used as an antimicrobial in various fields, including the medical industry, silver embedded fabrics, water purification, and vegetable disinfection (Jiang *et al*., 2004).

Ag^+, generally applied as silver thio sulfate, effectively inhibits ethylene-mediated processes (Ichimura*et al.*, 2008). As with other cations (e.g. K^+, Ca_2^+), positive effects on plant stem hydraulic conductivity of Ag^+ (van Ieperen*et al*., 2000) are possible. Also, Ag^+ is considered a general inhibitor of Aquaporins (AQPs) (Neimietz and Tyerman, 2002). AQPs are primary channels of water transport across biological membranes and are abundant in the vacuolar and the plasma membrane (Baiges*et al*., 2001). AQPs can increase the osmotic hydraulic conductivity of membranes by 10–20-fold (Preston *et al.*, 1992).

Glycerol (glycerine) has been used as a humectant to maintain the suppleness of harvested plant material (Romero-Sierra and Webb, 1982). Preservation is usually accomplished by standing cut stems in an aqueous solution of glycerol, allowing uptake via the transpiration stream (White *et al*., 1982; Paparozzi and McCallister,1988).

The aim of this study was to compare the role of silver nano-particles and glycerol with the standard practice of using aluminium sulphate as source to extend vase life and to keep postharvest quality of cut roses cv. ‘Taj Mahal’.

MATERIAL AND METHODS

The cut rose flower (*Rosa*x*hybrida*), ‘Taj Mahal’ were obtained from a commercial greenhouse at the outskirts of the city of Bengaluru, Karnataka, India. They were immediately transferred to the postharvest laboratory of the college of horticulture, Bengaluru, a sub-campus of University of Horticultural Sciences, Bagalkot, India. Cut flowers were harvested in the morning between 7 am-8am. Immediately after harvest, cut ends of the flowers were kept in a bucket containing water. These flowers were pre cooled at 2°C for four hours. After pre-cooling flowers were bunched and trimmed to 50-60 cm. These flowers were transported with their cut ends immersed in water to the laboratory which had average temperature of 25+ 2°C and 55 to 65 per cent relative humidity. The experiments were carried out the same day. The flower stems were re-cut under deionized water to a uniform length of 45 cm. Recutting was to ensure no air blockage of the stem end. Flower stems were places in glass bottles containing 100 ml of preservative solutions. The mouths of the bottles were then stuffed with non-absorption cotton so as to minimize evaporation loss and prevent contamination. Experiments were carried out in a Completely Randomized Design.

Vase solutions were freshly prepared at the beginning of experiments. A solution contains the following treatments.

T_1: Silver nanoparticles (SNP) 50 ppm + Sucrose 1.5% + Citric acid 300 ppm

T_2: Silver nanoparticles (SNP) 20 ppm + Sucrose 1.5% + Citric acid 300 ppm

T_3: Glycerol 6% + Sucrose 1.5% + Citric acid 300 ppm

T_4: Aluminium sulphate 300 ppm + Sucrose 1.5% + Citric acid 300 ppm

T_5: Sucrose 1.5% + Citric acid 300 ppm

Measurements

The rose flowers were considered senescent when showing at least one of the following symptoms of senescence: wilting of leaves or flowers, neck bending and incomplete bud opening (1). Water uptake, water loss and relative fresh weight were recorded daily by measuring weights of vases without flowers and of flowers separately.

- **Uptake of Water (G/ Cut Flower):** Difference between consecutive weights of bottle plus solution gives uptake of water of cut flower and represented in grams.
- **Transpiration Loss of Water (G/ Cut Flower):** Difference between consecutive weights of bottle plus solution plus cut flower gives transpiration loss of water of cut flower and expressed in grams.
- **Water Balance (G/ Cut Flower):** Water balance of cut flower was calculated by using the formula given below.

  Water balance = Water uptake – Transpiration loss of water
- **Relative Fresh Weight (RFW) (%):** The difference between the weight of the container and vase solution (with flower) and the weight of container and the vase solutions (without flower) were recorded at every alternate day interval to measure the fresh weight change of flower during that particular duration of period (He *et al*., 2006).The weight of flower stalk on the first day of each experiment was assumed to be 100 per cent. Subsequent weights were referred to as percentage of the initial value.

  RFW (%) = (fresh weight of stem on mentioned day/fresh weight of stem on initial day) x 100

RESULTS AND DISCUSSIONS

In the current study different concentrations of nano-silver (NS) in comparison with aluminium sulphate and glycerol were used as main source of variation. Results showed that these preservative solutions could extend the vase life of cut roses. Significant differences were found various treatments in extending the vase life of rose flowers.

Uptake of Water (G/Cut Flower)

Water uptake of flowers (Fig. 1) under all five treatments increased on second day except for T5/control (sucrose 1.5% + citric acid 300 ppm), although, water uptake values of other treatments were slightly on the higher side as on day two. TreatmentT_1 exhibited highest water uptake initially (day 1; 13.28 g) and there was no significant difference among the treatments. The rate of decrease reflected the freshness retention of the cut flowers under each treatment. With progression of days, there was reduction in water uptake by the cut flowers. Least rate of reduction in water uptake was observed in the treatments T_2, which, effectively suppressed the reduction in fresh weight compared to T_4 and T_5. Overall, T_2 was the best in terms of suppressing the reduction in water uptake. When flowers are cut from the mother plant, water loss from cut flowers continues through transpiration. As cut flower absorbs water from the vase solution it maintains a better water balance and flower freshness for long duration which in turn increases vase life. Although there was higher level of uptake of water in the initial stages, decline in the uptake of water was noticed in later stages of vase life. This could be attributed to development of microorganisms in vase water and microorganisms are considered to be one of the main causes to reduce uptake of water in cut flowers. Silver nanoparticles (SNP) may have a positive influence on the

water uptake because of antibacterial effects of Ag^+ ions in SNP may affect regulation of water channel activity via inhibition of sulfhydryl-containing proteins and improve solution uptake (Niemietz and Tyerman, 2002). Silver being a cation enhances solution and water flow through xylem vessels (van Ieperen*et al*., 2000).

Transpiration Loss of Water (G/Cut Flower)

As seen in Figure 2, it is noticeable that flowers held in treatment T_1 (50 ppm SNP + sucrose 1.5% + citric acid 300 ppm) registered the highest values with regard to transpiration loss of water. Flowers stems in treatment T_3 (glycerol 6 % + sucrose 1.5 + citric acid 300ppm) registered a more gradual and steady decline in the transpiration loss of water indicating stable maintenance of transpiration rate. Least transpiration loss of water was observed in the flowers held in vase solution containing glycerol 6% + sucrose 1.5 + citric acid 300 ppm. Glycerol, being an osmolyte, might have helped in maintaining of osmotic balance, thereby helping in moisture retention, which might have led to lower transpiration rates. Moreover, upon observation, it was evident that glycerol solution up take resulted in wilting of leaves which almost rendered the stems leafless by the end of study period. This might be one of the major factors for reduction in transpiration rate as the leaves were not functional to promote transpiration. On the other hand, T_1 (50 ppm SNP + sucrose 1.5% + citric acid 300 ppm)registered the highest values with regard to transpiration loss of water. Water deficit has direct effect on turgor of cut flowers, which accelerates wilting and senescence. The higher water uptake might be due to higher TLW to avoid temporary water stress. Silver ions enhanced water uptake due to microbe free conducting tissues and also delaying senescence by inhibiting ethylene generation. Minimum TLW in control was due to reduced water uptake (Balakrishna*et al.,* 1989).

Water Balance (G/Cut Flower)

On the second day of vase life, water balance of more than one gram was observed among all the treatments (Figure. 3). On fourth day, water balance values were less than zero gram per flower in all the treatments except for the treatment T_1 (50 ppm SNP + sucrose 1.5% + citric acid 300 ppm) and T_2 (20 ppm SNP +sucrose 1.5% + citric acid 300 ppm) with T_2being the best in maintaining better water balance compared to the other. The differences between water up take and water loss (water balance) determines the quality and longevity of cut flowers. Stem end blockage is a major factor for the imbalance between water uptake and water loss of cut flowers (van Doorn, 1997). Rose var. Taj Mahal cut flowers heldin vase solution containing 20 ppm SNP + sucrose 1.5% + citric acid 300 ppm had maintained significantly greater water balance. The differences among the treatments could be explained through the high water content of the flowers and leaves due to NS(nano silver) treatments which is a result of both high water uptake due to suppression of bacterial growth combined with inhibition of transpiration from the leaves due to reduced stomata aperture (Lu *et al*., 2010).

Relative Fresh Weight (%)

The relative fresh weight percentage under all five treatments increased till third day under treatments T_1, T_2 and T_3, but the flowers under treatments T_4 and T_5exhibited the increase only till second day indicating inability in maintaining freshness as compared to first three treatments (Fig 4). Decrease in relative fresh weight was more so gradual compared to T_4 and T_5 with only minimal loss in fresh weight with each passing day. Vase solution containing silver nanoparticles 20 ppm+ sucrose 1.5% + citric acid 300 ppm significantly suppressed the reduction in relative fresh weight percentage and emerged as the best treatment. Typically; cut flowers initially increase and subsequently decrease in relative fresh weight

(RFW) and vase solution uptake (VSU) (Rogers, 1973). Water absorption from the vase maintains a better water balance and flower freshness which saves from early wilting and reflecting on vase life improve. High value of fresh weight and relative fresh weight of cut flowers held in silver nano particle solutions were obtained compared to control cut flowers (sucrose 1.5% + citric acid 300 ppm) and T_4 {$Al_2(SO_4)_3$300 ppm+ sucrose 1.5% + citric acid 300 ppm} indicating higher rate of uptake of water by cut flowers and higher degree of freshness. The results are in conformity with the findings of (Lu *et al*., 2010) and (Kader, 2012) in roses.

CONCLUSIONS

In conclusion, in 'Taj Mahal' roses, using vase holding solution containing silver nanoparticles significantly extended vase life compared to the commonly followed procedure of using aluminium sulphate as floral preservative. Among the five treatments, the combination of silver nanoparticles 20 ppm+ sucrose 1.5% + citric acid 300 ppm was the best in terms of maintaining the water uptake and relative fresh weight and was also significantly on-par in maintaining water balance. Mobility of silver ion in stem of rose flowers is very slow. Therefore, application of nano particle with antimicrobial effects can improve speed of mobility and could prolong cut flower longevity.

REFERENCES

1. *Baiges, I., A.R. Schaffner andA.Mas. 2001. Eight cDNA encoding putative aquaporins in Vitis hybrid Richter-110 and their differential expression. Journal of Experimental Botany, 52: 1949–1951.*
2. *Balakrishna, H. V., R. T. Venkateshand R. B. G.Muthappa.1989. Postharvest physiology of cut tuberose as influenced by some metal salts. Mysore J. Agril. Sci., 23: 344-348.*
3. *Da-Silva, J.A.T. 2003. The cut flower: postharvest considerations. Online J. Biol. Sci., 3: 406-442.*
4. *Damunupola, J. W. and D. C.Joyce.2006. When is a vase solution biocide not or not only antimicrobial. J. Japan Soc. Hort. Sci., 77: 1-18.*
5. *Feng, Q. L., J. G. Q. Wu Chen, F. Z. Cui, T. N. Kimand J. O. Kim.2000.Mechanistic study of the antibacterial effect of silver ions on Escherichia coli and Staphylococcus aureus. J. Biomed. Mater. Res., 52: 662–668.*
6. *He, S., D. C. Joyce, D. E. Irving and J. D.Faragher.2006. Stem end blockage in cut Grevillea 'Crimson Yul-lo' inflorescences. Postharvest Biol. Tech., 41: 78-84.*
7. *Ichimura, K. and H.Shimuzu. 2007. Extension of the vase life of cut rose by treatment with sucrose before and during simulated transport. Bulletin of the National Institute of Floricultural Science, 7: 17–27.*
8. *Ichimura, K., S. Yoshioka and H.Yumoto-Shimizu.2008. Effects of silver thiosulfate complex (STS), sucrose and combined pulse treatments on the vase life of cut snapdragon flowers. Environ. Control Biol., 46: 155-162.*
9. *Jiang, H., S. Manolache, A.C.L. Wong and F. S.Denes.2004. Plasma enhanced deposition of silver nanoparticles onto polymer and metal surfaces for the generation of antimicrobial characteristics. J. Appl. Polym. Sci., 93: 1411-1422.*
10. *Kader, Abdel and H. Hesham. 2012. Effects of nanosilver holding and pulse treatments, in comparison with traditional silver nitrate pulse on water relations and vase life and quality of the cut flowers of Rosa hybrida L. cv. 'Tineke. World Appl. Sci. J., 20(1): 130-137.*
11. *Lu, P., J. Cao, S. He, J. Liu, H. Li, G. Cheng, Y. Ding and D. C. Joyce. 2010. Nano-silver pulse treatments improve water relations of cut rose cv. Movie Star flowers. Postharvest Biol. Technol., 57: 196-202.*

12. *Marandi, R. S., A. Hassani, A. Abdollahi and S. Hanafi. 2011. Application of Carumcopticumand Saturejahortensisessential oils and salicylic acid and silver thiosulfate in increasing the vase life of cut rose flower. J. Med. Plant. Res., 5(20): 5034-5038.*

13. *Morones J. R., L. E. Jose, C. Alejandra, H. Katherine, B. K. Juan, T. R. Jose and J. Y.Miguel.2005. The bactericidal effect of silver nanoparticles. Nanotechnol.,16: 2346–2353.*

14. *Niemietz, C. M. and S. D. Tyerman. 2002. New potent inhibitors of aquaporins: silver and gold compounds inhibit aquaporins of plant and human origin. FEBS Lett., 531(3): 443–447.*

15. *Preston, G.M., T. P. Carroll, W. B. Guggino, P. Agree. 1992. Appearance of water channels in Xenopus oocytes expressing red cell CHIP 28 proteins. Science, 256: 385–387.*

16. *Rogers, M. N. 1973.A historical and critical review of postharvest physiology research on cut flowers.Hort. Sci., 8: 189-194.*

17. *Shanan, T. N., K. S. Emaraand S. O. Barakat. 2010. Prolonging vase life of carnation flowers using natural essential oils and its impact on microbial profile of vase solutions. Australian J. Basic Appl. Sci., 4(8): 3559-3574.*

18. *Shimamura, M. and H. Okabayashi. 1997. Effect of silver thiosulfate (STS) on the vase life of Eustoma grandiflorum (Raf.) Shinners. Bull. Kochi Agric. Res. Cent., 6:53-58.*

19. *Van-Doorn, W. G. 1997.Water relations of cut flowers. Hort. Rev., 18: 1-85.*

20. *Van-Ieperen, W., U. van-MEETEREN and A. van-GELDER. 2000. Fluid ionic composition influences hydraulic conductance of xylem conduits. J. Expt. Bot. 51:769-776.*

APPENDICES

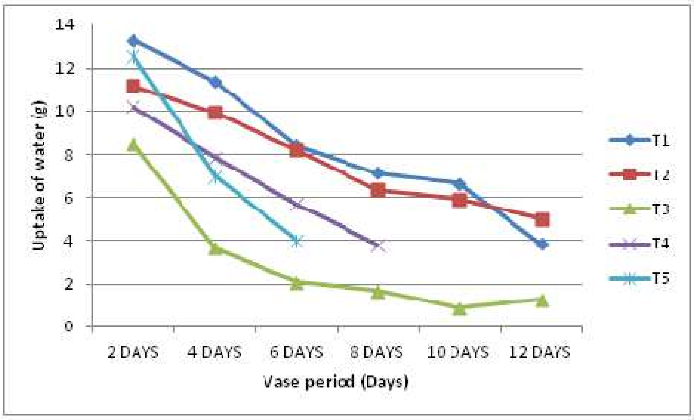

Figure 1: Effect of Various Vase Holding Solutions on Uptake of Water in Rose Var. Taj Mahal

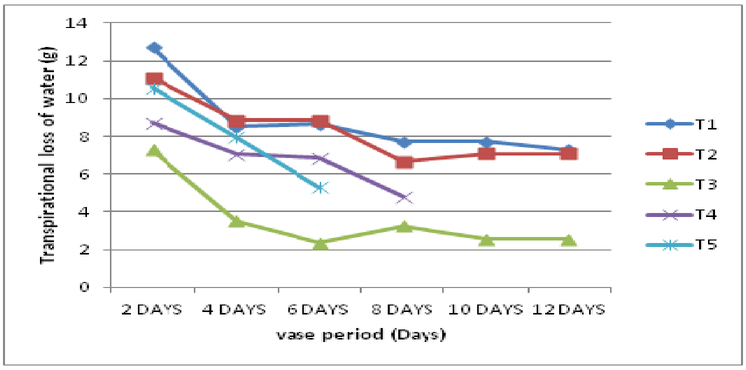

Figure 2: Effect of Various Vase Holding Solutions on Uptake of Water on Transpiration Loss of Water in Rose Var. Taj Mahal

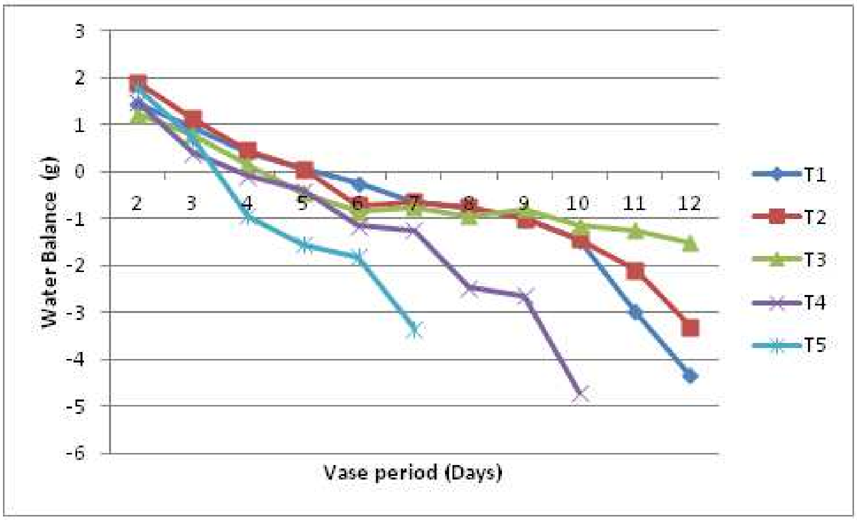

Figure 3: Effect of Various Vase Holding Solutions on Uptake of Water on Water Balance (G) In Rose Var. Taj Mahal

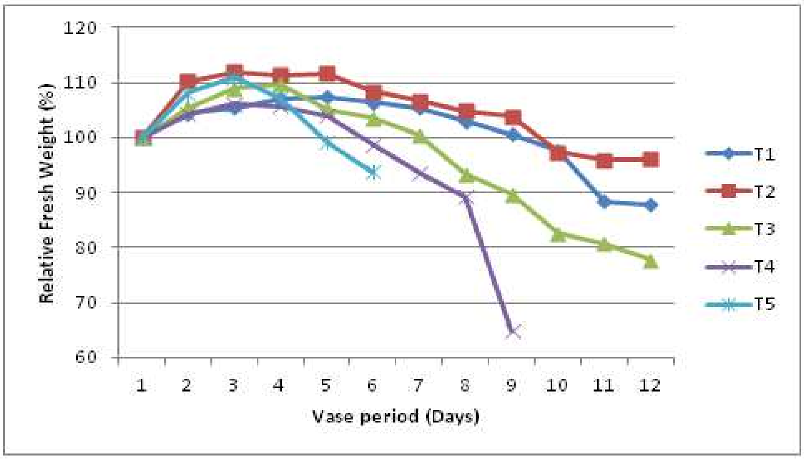

Figure 4: Effect of Various Vase Holding Solutions on Uptake of Water on Relative Fresh Weight (%) In Rose Var. Taj Mahal